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A COMPREHENSIVE STUDY ON THE SURFACE CHARACTERISTICS OF MICRO ULTRASONIC MACHINED CERAMIC-GLASS MATERIAL

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ABSTRACT

Objectives

The main Objetive of this paper is to find the surface characteristics of Ceramic glass machined by ultrasonic machining words.

Methods/Statistical Analysis

Ultrasonic machining (USM) procedure has for quite some time been utilized for manufacturing different examples and penetrating gaps on weak materials. In any case, the surfaces created by USM are ordinarily rather unpleasant and secured by profound infiltrated breaks. This has extraordinarily restricted USM being utilized as a part of small scale machining and fine machining.

Findings

This exploration planned to consider the surface honesty of the USMed surface and build up a practical approach to minimize the scattered splits so great surface complete could be accomplished. Machining parameters, for example, sort and grouping of rough particles, coarseness size, and sustain rate were efficiently researched to check their impacts at first glance got. A 'multi-arrange' small scale USM process was created in this study and surface with Ra esteem superior to anything 0.2µm was accomplished utilizing the proposed procedure.

Application/Improvements

By applying this machining process on materials like glass ceramics and composites the surface attained by the machining will be more accurate and burr free based on feed rate and concentration.

KEYWORDS: Ultrasonic Machining, Parameters, Ra, Glass Ceramic & Size

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INTRODUCTION

Attributable to the great optical and mechanical properties, materials, for example, glass, Zerodur, Fused quartz, SiC and silicon are broadly utilized as a part of industry. These materials are hard and weak. Subsequently, they are to a great degree hard to machine, particularly when there is miniaturized scale structures manufacture included. Crushing, lapping and cleaning are ordinarily used to manage greater estimated work-pieces[1,2].

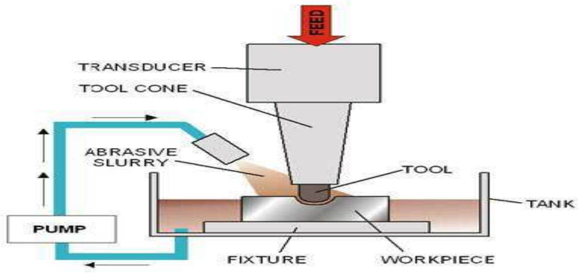

Figure 1: Schematic Diagram of Ultrasonic Machining

Laser removal, smaller scale EDM (electro-release machining) can just adequately deliver miniaturized scale structures on polymers and electrical conductive materials individually. With regards to the FIB (centered particle pillar) prepare, it is costly and more suited for innovative work. Smaller scale ultrasonic machining (MUSM) is thought to be a promising option for proficiently and precisely creating microstructures on weak materials [3,4,5] Being a non-warm, non-concoction and non-electrical machining, it has the benefits of no warmth influenced zone. Nonetheless, the got surfaces are all in all harsh and loaded with small scale breaks. That was created by the small scale chipping ruled material evacuation component of MUSM [6, 7, 8] This examination planned to explore the surface uprightness of the MUSMed glass-clay material and in this manner enhance it by changing the MUSM procedure.

EXPERIMENTATION

A Sonic-MillSM Stationary process USM machine was utilized in this study. The vibration recurrence of the wavering framework was settled at 20kHz in the present study and the sustain rate went from 0.1mm/min to 0.5mm/min. The glass-fired material Zerodur, having a low warm development coefficient around 0.02x10-6/K, was chosen as the material to be machined. Zerodur is effortlessly broken amid machining leaving profound infiltrating breaks inside the material. Every one of the Zerodur examples were pre-cleaned to a surface unpleasantness superior to anything 5nm Ra to minimize the break brought about by the pre-existed surface/sub-surface splits. Machining parameters, for example, kind of rough, coarseness measure, feedrate and grouping of abrasives were efficiently explored to check their impacts at first glance got. The MUSM parameters utilized as a part of the trials were recorded in Table 1. Surface profilometer (Alfa-step) was utilized to gauge the surface unpleasantness. The wedged cleaning and scratching system was utilized as a part of this study to uncover the sub-surface splits of the machined surface (Figure 1). Optical magnifying lens and checking electron magnifying instrument were used in conjunction with drawing system to look at apparatus wear and machined surface.

Table 1: MUSM Machining Parameters Investigated in this Experiment

SiC (μm)	Feed rate (mm/min)	Concentration (%)
60	1.5、1.0、0.5	5
12	1.5、1.0、0.5	5
5	0.5、0.1	5、10、20
2	0.1、0.05	20、33
1	0.1	20、33
Al2O3 (μm)	**Feed Rate (mm/min)**	**Concentration (%)**
0.3	0.1	33

SURFACE INTEGRITY OF THE MACHINED SPECIMENS

The trial comes about demonstrated that the surface honesty of the MUSMed example was significantly affected by the USM parameters. An unpleasant surface with scattered chipping and profound entered splits are regularly found when substantial coarseness measure abrasives as well as quick federate are utilized. As appeared in Table 2, greater coarseness size of abrasives brought about more profound sub-surface splits. The sub-surface splits created while utilizing vast grating could be enhanced in the event that it was trailed by a MUSM procedure utilizing better abrasives. In any case, it could be exceptionally hard to evacuate all sub-surface splits if the breaks had infiltrated too profound into the substrate.

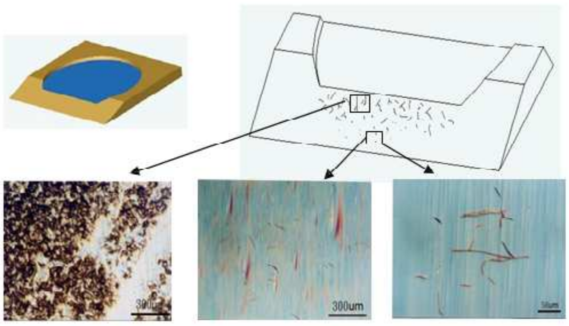

Figure 2: Sub-Surface Cracks and Microstructures Induced by 60µm Sic Investigated by Oblique Polishing and Etching Techniques

Table 2: Influence of Abrasive Size on the Sub-Surface Crack Involved During USM

SiC Abrasive Particle Size (Mm)	Depth of Sub-Surface Crack (Mm)
60	16.0
15	10.4
2	5.0
60 followed by 2	12.0

With regards to the grouping of abrasives, it was found that too high a grating focus would regularly bring about a poor surface complete because of abrasives got as well "swarmed" and, rather than expelling material by energized rough particles, abrasives were regularly squeezed against the work-piece to evacuate material. The best grating fixations found in this study were 5% for 60 µm SiC, 10% for 5 µm SiC, 20% for 2 µm SiC and 33% for 0.3 µm Al2O3.

Under similar swaying abundancy/recurrence and utilizing similar abrasives, slower feedrate for the most part means better surface unpleasantness and shallower sub-surface breaks. This could be obviously observed in Figure.2 where SiC abrasives of 5µm in coarseness estimate and 5% in focus were utilized to machine Zerodur under different feedrate.

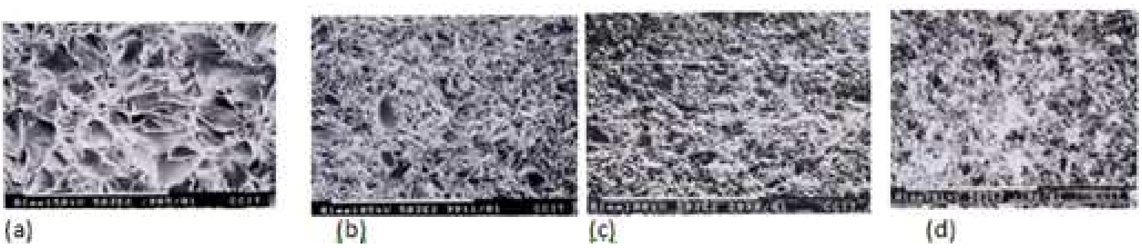

Figure 3: Effect of Feedrate(*Fr*) on the Surface Roughness of Musmed Zerodur Using Sic Abrasives of 5µm in Diameter and 5% in Concentration, (A) *Fr* =1.3mm/Min, Ra=1.15µm, (B) *Fr* =1mm/ Min, Ra=1.06µm, (C) *Fr* =0.45mm/Min, Ra=0.86µm, (D) *Fr* =0.2mm/Min, Ra=0.55µm

Improving surface roughness ratio by ‘multi-stage’ USM process With regards to the grouping of abrasives, it was found that too high a grating focus would regularly bring about a poor surface complete because of abrasives got as well "swarmed" and, rather than expelling material by energized rough particles, abrasives were regularly squeezed against the work-piece to evacuate material. The best grating fixations found in this study were 5% for 60 μm SiC, 10% for 5 μm SiC, 20% for 2 μm SiC and 33% for 0.3 μm Al2O3.

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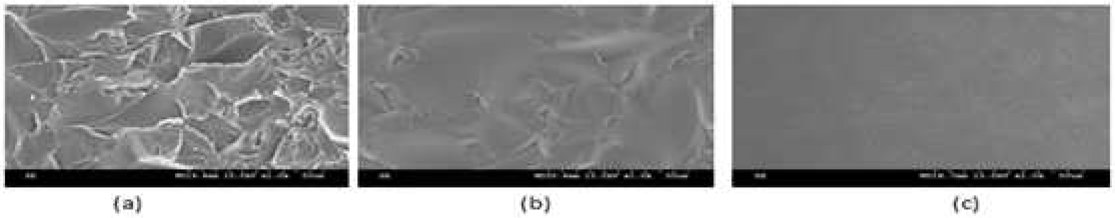

Figure 4: SEM Micrographs of the Surface Obtained by MUSM

CONCLUSIONS

- The surface honesty of the MUSMed example was significantly impacted by the swaying plentifulness, recurrence and bolster rate of the MUSM apparatus, and the sort, coarseness size and grouping of abrasives utilized.
- A harsh surface with scattered chippings and profound entered breaks were typically found when extensive coarseness estimate abrasives or potentially quick encourage rate were utilized.
- Too high a grating fixation would ordinarily bring about a poor surface wrap up. The best rough focuses found in this study were 5% for 60 μm SiC, 10% for 5 μm SiC, 20% for 2 μm SiC and 33% for 0.3 μm Al2O3.
- Under similar wavering abundancy/recurrence and utilizing similar abrasives, slower feedrate by and large means better surface harshness and shallower sub-surface splits.
- It was observed that great surface complete can be accomplished without surrendering an excessive amount of effectiveness by the proposed 'multi-organize' smaller scale USM prepare where coarse abrasives/substantial sustain, fine grating/little nourish and fine abrasives/staying were done regulated.

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